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ABSTRACT

The use of multiple regression in identifying students with learning disabilities was investigated with 281 ninth grade students. Five sets of predictor variables were chosen to predict grade point average in grade 9: verbal and nonverbal IQ, sex, socioeconomic status (SES), and grade point average in grade 7. Five groups of overachievers, normal achievers, and underachievers (learning disabled) were obtained using the predictor variables in the following sets: Set 1--verbal and nonverbal IQ; Set 2--verbal and nonverbal IQ and sex: Set 3--verbal and nonverbal IQ, sex, and SES: Set 4--grade point average in grade 7: and Set 5--verbal and nonverbal IQ, sex, SES, and grade point average in grade 7. The influence of different sets of predictor variables on the identification of learning disabled Ss was determined by counting the numbers of Ss identified as learning disabled by all five, four, three, two or only one of the sets of predictor variables. Results led to conclusions such as that multiple regression takes the multivariate nature of learning disabilities into account and the use of more than one predictor increases the accuracy of the potential achievement. (SB)

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THE INFLUENCE OF DIFFERENT SETS OF PREDICTOR VARIABLES ON THE IDENTIFICATION OF LEARNING DISABLED CHILDREN AND ON FACTORS ASSOCIATED WITH LEARNING DISABILITY

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THE INFLUENCE OF DIFFERENT SETS OF PREDICTOR VARIABLES ON THE IDENTIFICATION OF LEARNING DISABLED CHILDREN AND ON FACTORS ASSOCIATED WITH LEARNING DISABILITY*

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There is little agreement in the literature on the definition of learning disabilities and on the criteria for identifying children with learning disabilities. A survey by Mercer et al. (1976,p.47) revealed a variety of definitions used by state departments of education in the United States. Definitional confusions and inconsistences also became apparent in surveys of definitions used by professionals (Li 1977 p. 257). A definition which is more generally agreed upon is necessary for the classification of learning disabled pupils and for determining the incidence and prevalence of learning disability as well as for the planning of remedial strategies.

It is the objective of this paper to show that multiple regression may be used in identifying pupils and students who have learning disabilities. An operational definition in which multiple regression is used will be less nebulous than those definitions which are currently accepted. The choice of the predictor variables used in predicting learning potential is critical to the classification and incidence of pupils with learning disabilities. A second objective of this paper is to show empirically that the choice of predictor variables not only determines the categorization of learners as learning disabled but also influences the identification of factors related to learning disabilities.

The discrepancy between potential or estimated ability and actual educational achievement seems to be the one characteristic on which all experts agree. (Li 1977, p. 257; Mercer et al. 1976, p. 51; Wyne and O'Connor 1979, p. 259).

The discrepancy criterion is used by writers such as Myklebust (1972, p. 284) and in operationalizing learning disability in research (e.g. Bruininks and Bruininks 1977; Patton and Offenbach 1978). The learning disabled child is an under-achiever who fails to perform as well as a specified set of variables would predict. In the discrepancy criterion two performances are compared, viz actual and potential performances. These two aspects deserve further attention.

It is generally accepted that actual performance is operationalized to grade point average, achievement in a specific subject and scores on standardized scholastic achievement tests especially in reading, writing, spelling and arithmetic.

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3. The research was part of a sub-project of this larger project by D.Ed.-candidates A J Eksteen, P J S du Toit and H J Putter.

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There is less agreement on the variables which should be included as predictors of potential performance and on the way in which these predictors are used for identifying learning disabled children. Historically intelligence tests or measures of educational aptitude have been used for the prediction of performance although this has not been explicitly mentioned in the well-known NACHC definition of learning disabilities. Intelligence is a reasonably good predictor of scholastic achievement. Apart from scholastic achievement itself there is no other variable which predicts scholastic achievement as well as intelligence. The correlation of single tests of ability or intelligence with grade point average is typically around .5 (Butcher 1973 p. 282; Bloom 1976, p. 52). This means that intelligence explains only about 25% of the variance in scholastic achievement. It is clear that the remainder of the variance is presumably determined by such factors as sex, conditions at home, motivational factors or work habits. More than one factor should therefor be used to predict potential performance. There is, however, little agreement on the other variables to be used. There are only a few child characteristics which provide a solid basis for the prediction of school success (Keogh and Becker 1973, p. 6).

Another problem in identifying the learning disabled child is to determine the way in which intelligence should be used to predict potential performance and to decide on the size of the discrepancy in order to label a child as learning disabled. In the state of Florida e.g. the academic deficit component is based on a student's expectancy age with a resultant score in the lower 10th percentile in one or more of the following areas as measured by standardized tests: reading, writing, arithmetic, spelling and prerequisite skills (Mercer et al. 1976, p. 55).

It is generally accepted that only students with average or near average mental ability should qualify to be labelled as learning disabled. There is however disagreement as to the point along the continuum of measured intellectual capacity which should cut off the retarded child from the learning disabled (Smith, Coleman, Dokecki and Davis, 1977, p. 353). It may be an IQ of 90 (Hammill 1976, p. 34) or 80, 85 or even as low as 70 as proposed by Mercer et al. (1975, quoted by Smith et al. 1977, 353).

The discrepancy is not the only commonly-found criterion in definitions of learning problems. Others such as the exclusion criterion, according to which mentally retarded children and children with auditory and visual impairment or emotional disturbances are excluded, are equally important for the purpose of this study.

Another component of the definition which has remained controversial is the question of the involvement of the central nervous system. (Li 1977, p. 257). Sometimes neurological dysfunction is regarded as a necessary condition of learning disabilities. It should however rather be regarded as the main cause or one of the causes of learning disabilities. These causes may change with development and should therefore not be used in an all-inclusive definition. Neurological dysfunction is an important cause of learning disabilities for the preschool and primary school child and continues to give rise to difficulties throughout a student's school career but its relative influence on learning diminishes as the child grows older.

By using multiple regression in the identification of learning disabled children most of the above-mentioned problems in defining learning disabilities could be solved. Multiple regression is

extremely suitable for predicting potential performance which is based on several factors. By adding other independent variables to the one most commonly used, viz. intelligence, the predictive power could be raised considerably.

One should be highly cautious in selecting other variables in addition to intelligence. These variables should have a high correlation with scholastic achievement in general and should not include the causes of learning disability such as neurological dysfunctions. The chances are small of identifying a factor as a cause of learning disability if this factor is included in the set of predictor variables.

In this study five sets of predictor variables were chosen to predict grade point average in grade 9 from the following variables: verbal and non-verbal IQ, sex, SES and grade point average in grade 7. The choice of the IQ scores is obvious. Sex was chosen because males suffer more than females from learning disabilities. According to Critchley (quoted by Fincham 1977, p. 155) males outnumber females by a ratio of 5:1 in the population of retarded readers. In almost any sample of children with learning problems, 80% of them will be male (Farnham-Diggory, 1978, p. 54). Males are slower to develop than females and this fact should be taken into account when predicting potential performance. SES was also included in the sets of predictor variables because of the correlation (about 0.2) with scholastic achievement. Grade point average in grade 7 is probably one of the best predictors for grade point average in grade 9 ($r = 0.58$). It is also argued that learning disabilities may develop during the student's school career. In such a case grade point average in a previous grade is the most suitable predictor variable for identifying this variation of learning disabled children.

METHOD

Subjects

Eleven classes comprising 281 students were randomly selected from all grade 9 classes (124 in number) in Afrikaans schools in the Southwestern Transvaal region, South Africa. Only "ordinary course" pupils were included in the population. "Practical course" pupils were excluded because they follow a different curriculum from the "ordinary course" pupils. The grade point averages of the "practical course" students are not comparable to those of the "ordinary course". The "practical course" pupils typically do poorly at school and mostly have an IQ less than 90. They comprise about 16% of the junior high school population. The average IQ of the sample of "ordinary course" students was 104.9 (standard deviation = 11.0).

The sample consisted of 144 boys and 137 girls. The average age was 16 years 0 months.

Procedure

Grade point averages and verbal and non-verbal IQ's were obtained from the school records. The IQ's of the students were determined by the New South African Group Test (1965) which is the most commonly used group intelligence test in South African schools. This test was administered to the students about two years prior to the conducting of this experiment.

The sex of the students and the socio-economic status (SES) were determined by means of a questionnaire. SES was a composite score based mainly on the career of the father but also on the career of the mother, educational level of the parents and size of the house.

Multiple regression analysis was used to predict grade point average in grade 9 using consecutively one of each of the five sets of variables mentioned earlier as predictors. For each one of the five sets of predictor variables a predicted grade point average for every subject was thus obtained. These five predicted grade point averages were considered to be the expected or potential achievements of S or to be indices of the capacity of S based on the five sets of variables used to define capacity or potential achievement operationally.

The actual achievement of S was operationally defined as the grade point average of each pupil.

The difference between the capacity of S and actual achievement was determined by subtracting the actual score from the predicted score for each one of the five sets of predictor variables. If this difference was positive, S was labelled as an over-achiever and if this difference was negative, S was labelled an under-achiever or as a student with learning disabilities. For each set the Ss with the highest positive differences were identified and labelled as the overachieving group (A^+). The 30 Ss with the smallest differences between capacity and actual performance were considered normal achievers (A) and the Ss with the highest negative differences were labelled as the under-achieving group or the group with the most severe learning disabilities (A^-).

This was done five times (once for each set of predictor variables).

In this way the following five groups of overachievers, normal achievers and underachievers (learning disabled) were obtained using the predictor variables in the following sets.

Set 1 : Verbal and non-verbal IQ.

Set 2 : Verbal and non-verbal IQ and sex.

Set 3 : Verbal and non-verbal IQ sex and SES.

Set 4 : Grade point average in grade 7.

Set 5 : Verbal and non-verbal IQ, sex, SES and grade point average in grade 7.

The number of Ss identified as learning disabled (or underachievers) by all five sets of predictors were obtained. This was repeated to obtain the numbers of Ss identified by four, three, two or one procedure.

The composition of the groups was not independent: many Ss were members of more than one group. The overachieving, normal achieving and under-achieving subgroups were in all five cases independent of each other: the same S was never a member of more than one of the over-, normal or under-achieving groups.

The differences between the means of the three groups on intelligence and age were negligibly small except for a difference in mean IQ for set 4 (Table 1). The groups could therefor be compared on the dependent variables.

Table 1

Means of intelligence and age for A^+, A , A^--groups composed by the five sets of predictor variables

	Set 1			Set 2			Set 3			Set 4			Set 5		
	A+	A	A-	A+	A	A-	A+	A	A-	A+	A	A-	A+	A	A-
Mean age (in months)	192	193	193	192	193	192	192	190	192	191	192	194	193	191	193
Mean IQ	106	102	109	106	100	108	107	105	107	111	99	98	105	103	104

Consequently a questionnaire and tests were given to all 281 Ss. In the further analysis only the data obtained from those Ss who had been identified as described above (A+, A, A-groups) were used. Twenty variables were chosen. Some are school-related (numbers 1, 18, 19, 20 in table 3), some are related to conditions at home and relationships with parents (numbers 2 - 9) and some are personality characteristics (numbers 10 - 17).

The following variables were measured by having the Ss answering a questionnaire:

* number of schools which the S attended;

* the completeness of the family (a complete family was defined as one in which two parents were at home) and

* the time the father is at home.

The following variables were measured using certain published or translated tests or tests which were constructed for the purpose of this study:

* parental concern of the father for the child as experienced by the child. (A test was constructed by Eksteen (1981) using items such as "I get the feeling that my father is available if I need help or assistance".);

* attitude towards father and attitude towards mother as measured by the "Attitude towards Parents" scale of Itkin. (Shaw and Wright, 1967);

* identification with the father and identification with the mother as measured by a test constructed by Eksteen (1981) (items such as the following were used: "I think my father is reckless");

* adjustment at home, health adjustment, submissiveness, emotionality hostility and masculinity - femininity were measured by using the Bell Adjustment Inventory (Bell, 1963);

* self-concept was measured by a self-concept test constructed by Vrey (Vrey, n.d.) for adolescents;

* anxiety as measured by the IPAT Self-Analysis Form, constructed and standardised by the Human Sciences Research Council in South Africa;

* sense of identity was measured by a scale constructed by Putter (Eksteen, 1981, p. 788) using items such as "I know exactly which career I want to follow", or "Sometimes I do not know what is expected of me");

* a measure on school related affect was obtained by summing up the scores on the Self-concept of Academic Ability of Brookover (Cohen 1976, p. 111) the School Opinion Questionnaire (Cohen 1976, p. 75) and the Academic self-image scale of Barker-Lunn (Cohen 1976, p. 110);

* anxiety about teachers was measured by asking Ss if they are anxious about the teachers in the different subjects. All the yes-answers were given 1 point and all the no-answers received a zero. These points were summed to get a point for anxiety about teachers;

* likability of teachers was measured in a parallel way by asking Ss if they like or dislike their teachers in the different subjects.

The means for groups A+, A and A⁻ on each one of these 20 dependent variables were compared for each of the five identification procedures (or five sets of predictor variables used).

RESULTS

The influence of the use of different sets of predictor variables on the identification of learning disabled Ss was determined by counting the numbers of Ss identified as learning disabled by all five, four, three, two or only one of the sets of predictor variables. The results are given in table 2. A total of 63 Ss were selected by one or more of the procedures.

Table 2

Frequencies and percentages of total of 63 Ss identified as learning disabled by one to five procedures

Number of procedures by which Ss were identified as LD	Number of Ss identified as LD	Percentage of total number of Ss identified as LD
LD in all 5 procedures	11	17.5
LD in 4 procedures	4	6.3
LD in 3 procedures	11	17.5
LD in 2 procedures	9	14.3
LD in 1 procedure	28	44.4
	63	100.0

It appears from table 2 that Ss identified as learning disabled differ according to the set of predictor variables used to obtain an expected score. Twenty-eight of the 63 Ss were identified by only one procedure and only 11 Ss were identified by all 5 procedures.

The influence of different sets of predictor variables on the factors associated with learning disability was determined by comparing the means on the 20 variables for each one of the five sets of predictor variables. Analysis of variance was used to test for the significance of the differences between the means of the over-, normal or underachievers on the 20 variables on which measures were obtained. The p-values obtained from the analysis of variance are given in table 3.

Table 3 : see next page

Table 3

p-values obtained to test the significance of the differences between means of groups A^+, A, A^- on 20 variables with A^+, A, A^- composed by using five different sets of predictor variables

Variable	Set 1	Set 2	Set 3	Set 4	Set 5
1. Number of schools	0.002**	0.011*	0.006**	0.277	0.141
2. Completeness of family	0.026*	0.111	0.010*	0.747	0.673
3. Time father at home	0.446	0.535	0.162	0.132	0.225
4. Parental concern of father	0.138	0.011*	0.281	0.576	0.483
5. Attitude towards father	0.334	0.709	0.676	0.066	0.201
6. Attitude towards mother	0.071	0.135	0.208	0.257	0.970
7. Identification with father	0.387	0.303	0.394	0.432	0.399
8. Identification with mother	0.100	0.102	0.110	0.740	0.741
9. Adjustment at home	0.002**	0.005**	0.002**	0.026*	0.014*
10. Health adjustment	0.302	0.172	0.054	0.343	0.308
11. Submissiveness	0.063	0.279	0.545	0.171	0.880
12. Emotionality	0.185	0.286	0.419	0.710	0.532
13. Hostility	0.908	0.977	0.783	0.257	0.683
14. Masculinity - Femininity	0.449	0.576	0.530	0.501	0.686
15. General anxiety	0.794	0.479	0.694	0.568	0.633
16. Self-concept	0.006**	0.005**	0.051	0.864	0.405
17. Sense of identity	0.001**	0.002**	0.028*	0.093	0.418
18. School related affect	0.000**	0.000**	0.000**	0.000**	0.000**
19. Anxiety about teachers	0.656	0.405	0.545	0.902	0.452
20. Likability of teachers	0.494	0.531	0.130	0.017*	0.231

* Significant at the 5% level

** Significant at the 1% level

In table 4 the means obtained in A^+, A and A^- and F-values are given for those variables on which one or more significant (5% level) differences were obtained.

The methodological approach used here is typical of what is being done in research on learning disabilities. Ss with learning disabilities are selected from the population and then compared to a control group which is equated to the experimental group on variables such as age, IQ and SES (e.g. Fincham 1977, p. 155; McSpadden and Strain 1977, p. 35; Bruininks and Bruininks 1977, p 1131). In this experiment and in the other, typical experiments on learning disabilities it is very difficult if not impossible to equate the learning disability group with the control group on actual achievement. The learning disability group will always have a mean achievement lower than the control group. The result is that a difference in means in the dependent variable will usually be found for those variables which show a relatively high correlation with actual achievement.

TABLE 4

MEANS, F-VALUES, P-VALUES FOR TESTING THE DIFFERENCES BETWEEN GROUPS A^+, A, A^- IN FIVE DIFFERENT SETS OF PREDICTOR VARIABLES FOR CERTAIN SELECTED DEPENDENT VARIABLES

VARIABLE	Set 1						Set 2						Set 3						Set 4						Set 5					
	Means				F	p[1]	Means				F	p	Means				F	p	Means				F	p	Means				F	p
	A^+	A	A^-	Total			A^+	A	A^-	Total			A^+	A	A^-	Total			A^+	A	A^-	Total			A^+	A	A^-	Total		
Number of schools	1.7	2.9	2.9	2.5	7.0	0.00**	1.8	2.7	2.8	2.4	4.7	0.01*	1.7	2.8	2.7	2.4	5.4	0.01*	1.9	2.3	2.4	2.2	1.3	0.28	2.2	2.9	2.5	2.5	2.0	0.14
Completeness of family	1.0	1.3	1.2	1.2	3.8	0.03*	1.1	1.4	1.2	1.2	2.3	0.11	1.0	1.4	1.1	1.2	4.9	0.01*	1.3	1.5	1.4	1.4	0.3	0.75	1.1	1.3	1.2	1.2	0.4	0.67
Parental concern of father	67.9	62.3	62.8	64.4	2.0	0.14	68.9	60.1	62.8	63.9	4.8	0.01*	67.7	63.3	66.5	65.9	1.3	0.28	68.5	67.0	65.4	66.9	0.6	0.58	68.0	67.5	65.1	66.9	0.7	0.48
Adjustment at home	6.7	9.7	13.3	9.9	6.7	0.00**	6.4	9.7	12.5	9.5	5.8	0.00**	5.8	7.8	11.5	8.4	6.9	0.00**	6.6	8.7	10.5	8.6	3.8	0.03*	6.8	7.0	10.9	8.2	4.5	0.01*
Self-concept	69.9	62.9	60.5	64.5	5.7	0.00**	70.2	62.9	60.9	64.7	5.8	0.00**	70.3	66.6	63.4	66.7	3.1	0.05	65.1	65.2	63.8	64.7	0.2	0.86	67.2	66.3	63.7	65.7	0.9	0.40
Sense of identity	21.9	19.3	18.5	19.9	7.2	0.00**	21.9	19.0	18.6	19.8	6.6	0.00**	21.7	19.9	19.4	20.3	3.7	0.03*	20.3	18.7	18.3	19.1	2.4	0.09	21.0	20.2	19.8	20.3	0.9	0.42
School-related affect	96.6	82.6	77.7	85.6	20.2	0.00**	96.7	81.9	77.5	85.2	23.3	0.00**	96.6	87.3	79.6	87.9	16.3	0.00**	94.3	84.4	80.1	86.2	10.2	0,00**	92.5	83.6	78.9	85.0	9.4	0.00**
Likeability of teachers	17.5	18.4	17.1	17.7	0.7	0.49	17.8	18.0	16.9	17.6	0.6	0.53	18.2	17.5	16.3	17.4	2.1	0.13	18.8	17.0	15.5	17.1	4.3	0.02*	17.7	16.8	15.9	16.8	1.5	0.23

* Significant at the 5% level; ** Significant at the 1% level
Degrees of freedom = 87

Apart from this methodological constraint of this experiment, repeated measures were taken from the same Ss. The significances of the differences should therefor be interpreted with some reserve.

In the light of these two methodological constraints tables 3 and 4 should be interpreted in a more encompassing view. The relative positions of the dependent variables are important for this discussion and not so much the significance of the differences between the individual dependent variables.

The general picture emerging from tables 3 and 4 is:

1. The differences between the means on some factors such as number of schools attended, self-concept and sense of identity are significant only for certain sets of predictors. The means of number of schools attended, completeness of family, selfconcept and sense of identity differ significantly (except for completeness of family in set 2, self-concept in set 3) in set 1, 2 and 3 but not in sets 4 and 5. n sets 1, 2 and 3 IQ, SES and sex were used as predictors and in set 4 only grade point average in grade 7 was used. In set 5 all the mentioned predictors were used. The means in likability of teachers differ significantly only in set 4. Students who are labelled as disabled when grade point average in a previous grade is used as predictor of potential performance dislike their teachers more than other students.

2. The means on some variables such as emotionality, general anxiety and attitudes towards parents do not differ significantly irrespective of the set of predictors used.

3. The differences between the means on some factors are significant irrespective of the sets of variables used to identify the three groups. Learning disabled students perform significantly lower than normal students in ~~school~~ related affect for all five sets of predictors. The adjustment at home of learning disabled students is poorer (a high score means a poor adjustment) than those of normal children for all five sets of predictors.

   In spite of the methodological limitations mentioned it is concluded that the size of the differences between the means of the variables and the very low p-values obtained for all five sets of predictors suggest that adjustment at home and school affect are very important causes of learning disability at the junior high school level.

DISCUSSION

It was shown that the selection of variables used to predict potential achievement determines not only the identification of students who are to be labelled as learning disabled but also influence the factors which are associated with learning disability. Moreover it became clear that multiple regression is extremely suitable for the selection of learning disabled children in both a research setting and in a school system where children are to be classified. (The reader is referred to Kerlinger and Pedhazur 1973, for a very good exposition of multiple regression)

Firstly it takes the multivariate nature of learning disabilities into account. Potential achievement is not a function of one factor only such as intelligence but of many more interrelated and interactive factors. Learning disabilities should be seen as multilevel and multifactorial deficits for which multivariate statistical procedures are most appropriate (Webster and Schenck 1978, p. 79; Mallinger 1977, p. 767).

Secondly the use of more than one predictor increases the accuracy of the prediction of the potential achievement. This is evident from the correlations in table 5 between the actual achievement and the different sets of predictors (calculated from the orginal sample of 281 Ss):

Table 5

Correlations between different sets of predictors and actual achievement

	Set 1	Set 2	Set 3	Set 4	Set 5
r	0.56	0.57	0.61	0.58	0.75
percentage of variance explained	32	32	37	33	57

Thirdly learning disability is not treated as an all-or-none or dichotomous phenomenon but as a continuum. Learning disabilities can be seen as spanning a continuum from mild difficulties to severe difficulties resulting in debilitating learning handicaps (Sanders 1979, p. 46).

Fourthly, using this method does not exclude by definition the 80-90 IQ range. Even the retarded child may have learning disabilities.

In the fifth place, it can be used for children at all levels of development and for different combinations of predictor variables. It is suitable to use when the learning disability in a particular area such as spelling is to be identified. In this case achievement in related areas such as reading and writing may be used as predictors.

Lastly, it is simple to understand and easy to use.

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